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Operational Satellite Systems

During the 50 years since the first Vela satellites, the United States developed and maintained an evolving constellation of operationally vigilant, space-based sentinels for nuclear detonation treaty verification. A multitude of sophisticated sensors developed at Los Alamos and Sandia national laboratories, each evolving and benefitting from continual advances in electronics and sensor technologies, monitors for electromagnetic and energetic particle emissions associated with aboveground detonations. Following Vela, the sensing payloads deployed on Defense Support Program (DSP) and Global Positioning System (GPS) satellites form the core of this capability, called the U.S. Nuclear Detonation Detection System.

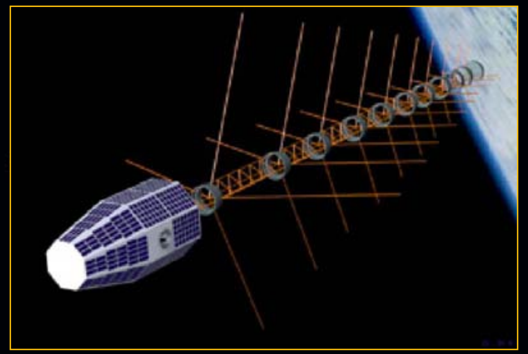
Experimental Satellites and Payloads

To ensure optimum capability from the operational treaty verification satellite program, the Department of Energy/National Nuclear Security Administration, through its Los Alamos and Sandia national laboratories, supports a program of experimental satellites and sensing payloads to demonstrate and validate new technologies and capabilities. These demonstration missions included the Array of Low Energy X-ray Imaging Sensors (ALEXIS), Fast On-orbit Recording of Transient Events (FORTÉ), and Cibola Flight Experiment (CFE) satellites as well as experimental payloads on the Space Shuttle, the Space Station, and other spacecraft.

The new technologies and capabilities demonstrated through these relatively small, low-cost missions are folded into the next generation of operational sensors for the nuclear detonation detection mission.


Defense Support Program (DSP) Satellite (Credit: USAF)


Global Positioning System (GPS) Satellite (Credit: USAF)


FORTÉ Experimental Satellite (Credit: LANL)

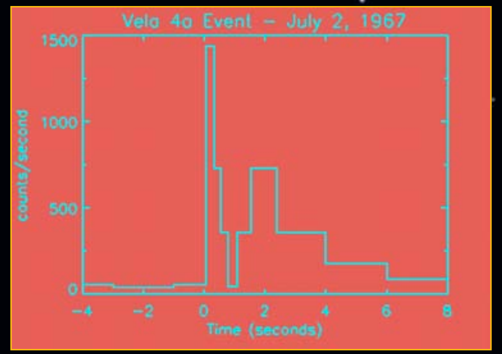

Preparing the ALEXIS Experimental Satellite (Credit: LANL)

A Boon to Space Science

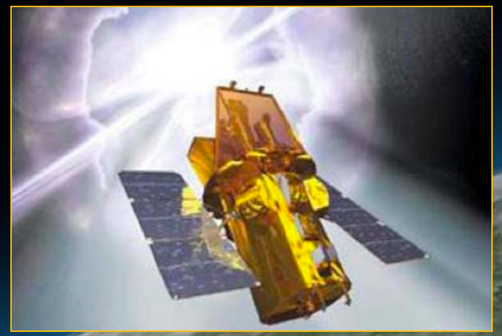
The sensors that monitor for nuclear detonations also receive and record signals from natural events in the atmosphere and near-Earth space, reaching to the most remote areas of the universe.

The Vela satellites discovered bursts of gamma-ray energy emanating from beyond the solar system. Scientists now understand that these bursts originate from extraordinary supernova explosions or stellar mergers in distant galaxies, releasing in an instant more energy than the combined output of all the stars in the Milky Way. Vela instruments also discovered iron, silicon, and other heavy ions in the Solar wind and made seminal observations of structures and interactions in Earth's enveloping magnetic field.

The ground-breaking scientific discoveries and sensor technologies from Vela and subsequent treaty monitoring satellite systems led directly to several focused NASA scientific missions exploring space around Earth, the solar system, and interplanetary space.



First recorded cosmic gamma-ray burst measured with Vela (Credit: R. Klebesadel, I. Strong & R. Olson (LANL)


NASA Swift Spacecraft devoted to the study of cosmic gamma-ray bursts (Credit: NASA/GSFC)

The U.S. Nuclear Detonation Detection System is managed as a joint program between the U.S. Air Force and the Department of Energy, National Nuclear Security Administration with its Los Alamos and Sandia national laboratories.
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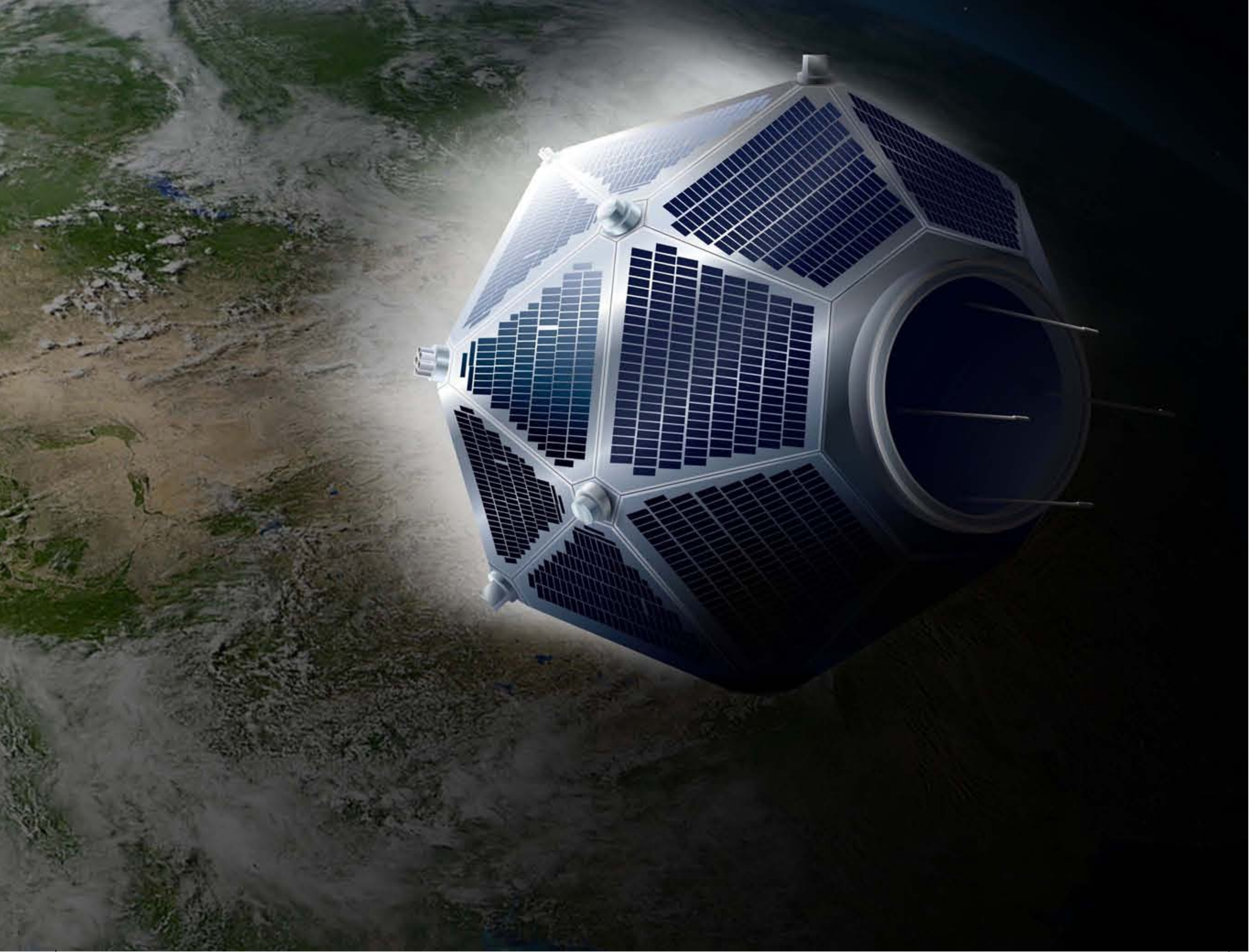
Los Alamos NATIONAL LABORATORY EST. 1943

Ensuring America's Security

50 Years of Treaty Verification from Space



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50 Years of Treaty Verification from Space

On October 10, 1963, the United States, the Soviet Union, and the United Kingdom adopted the Limited Test Ban Treaty pledging to refrain from testing nuclear weapons in the atmosphere, underwater, or in outer space.

Seven days later the United States launched the first pair of Vela [short for “watchman” in Spanish] satellites into Earth's orbit with the mission to verify compliance with the newly established treaty. The combination of these events abruptly ended a dangerous era of accelerated atmospheric and space-based nuclear weapons testing.

The rapid development and success of the Vela satellite program marked the beginning of an enduring space-based treaty verification system that continues to enhance America's security today and beyond. This display recounts the history of the Vela satellite program and its continuing legacy.

Trinity detonation (Credit: LANL)

Launch of a GPS Satellite on a Delta rocket (Credit: USAF, 2007)

July 1945
United States tests world’s first atomic bomb, Trinity. One month later, atomic bombs are dropped on Hiroshima and Nagasaki, Japan.

August 1946
U.S. Congress passes the Atomic Energy Act that transfers atomic energy responsibility from the Manhattan Engineering District to the Atomic Energy Commission (AEC).

September 1947
General Eisenhower tasks the Army Air Forces with the overall responsibility to detect atomic explosions anywhere in the world.

August 1949
USSR detonates its first nuclear weapon.

1950

November 1952
United States explodes first hydrogen bomb; USSR follows in Aug. 1953.

May 1955
USSR first proposes a halt in nuclear weapons testing.

October 1957
USSR launches Sputnik, the world’s first artificial satellite.

December 1957
U.S. Vanguard satellite explodes on launch pad.

January 1958
United States launches its first successful satellite, Explorer 1, whose instruments discover the Van Allen radiation belt surrounding the Earth.

July 1958
Geneva Conference of Experts meets to discuss a control system to monitor for nuclear tests.

August 1958
United States detonates Argus I, first nuclear weapon in outer space.

February 1959
USAF launches first of Discoverer satellite series.

May 1959
Panofsky Panel (High Altitude Detection Panel of President’s Science Advisory Committee) recommends a satellite system be used to detect nuclear tests in space and in the atmosphere.

June 1959
AEC directs scientists at Los Alamos and Sandia laboratories to consider technologies for monitoring nuclear explosions above the Earth’s surface.

July 1959
Technical Working Group I of the Geneva Conference on Discontinuance of Nuclear Weapons recommends “placing five or six satellites in earth orbit at a distance of 180,000 miles to detect radiations from nuclear explosions in space.”

September 1959
DoD funds ARPA for research in nuclear test monitoring technology. ARPA teams with AEC’s Los Alamos and Sandia laboratories, which have already been working on the problem. Vela program begins.

“ ... at that time ... the technology did not exist for fabricating reliable spacecraft of the required complexity.”

1960

December 1960
USAF, NASA, and AEC representatives meet to define satellite system to detect nuclear explosions in space.

June 1961
ARPA approves five satellite launches under the Vela Hotel program Los Alamos and Sandia continue work on design and development of detection instrument systems

September 1961
Arms Controls and Disarmament Agency formed, later to be merged into the Department of State.

December 1961
Space Technology Laboratory, a subsidiary of the Ramo-Wooldridge Corporation selected as spacecraft contractor.

1961-62
AEC flies experimental detectors for nuclear detection on USAF Discoverer satellites.

October 1962
Cuban Missile Crisis.

November 1962
United States conducts its last atmospheric nuclear test; USSR follows a month later.

March 1963

“Detectors of this kind (gamma ray, x-ray and neutron) are now in a state of mass production at Los Alamos and Sandia. The physics design of these detectors is completed, meaning that careful consideration has been given to output signals from a nuclear explosion, and consideration of how to detect those signals has gone into this design and how to discriminate against natural radiations in space.”

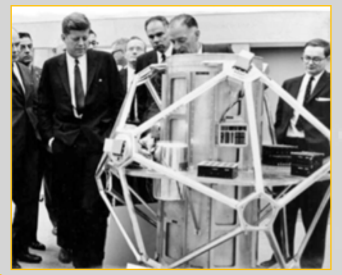
Testimony before the Joint Committee on Atomic Energy

October 1963
Limited Test Ban Treaty goes into effect; Launch of the first pair of Vela satellites.

July 1964
Launch of the second pair of Vela satellites.

October 1964
China detonates its first nuclear weapon.

July 1965
Launch of the third pair of Vela satellites.



President Kennedy visits Vela Project at Sandia and Los Alamos. (Credit: SNL, 1962)

1970

March 1970
United States ratifies the Nuclear Nonproliferation Treaty, which set a precedent for international cooperation between nuclear and non-nuclear states to prevent proliferation.

November 1970
Launch of the first Defense Support Program satellite with nuclear detonation detection technology including optical, x-ray, neutron, and gamma-ray sensors.

June 1973
First published reports of cosmic gamma-ray bursts, as recorded by instruments on the Vela 5 and 6 satellites from 1969 to 1972.

September 1974
France conducts its last atmospheric nuclear test.

1980

April 1980
Deployment of the first nuclear detonation detection payload on a Global Positioning System (GPS) satellite.

October 1980
China conducts its last atmospheric nuclear test.

September 1984
Last of the Vela satellites, though still functioning, officially turned off, 15 years after its launch.

1990

April 1993
Launch of ALEXIS, an experimental satellite to demonstrate new technologies and capabilities for x-ray and radio frequency nuclear detonation detection.

July 1997
Modernized nuclear detonation detection payload launched aboard the GPS’s Block IIR series of satellite signals.

August 1997
Launch of FORTÉ, a satellite test-bed for nuclear detonation detection technologies. Built using a graphite-reinforced epoxy structure that weighed only 90 pounds, FORTÉ carried a broadband radio receiver, optical detector and event classifier to distinguish between natural and human-made electromagnetic signals.

2000

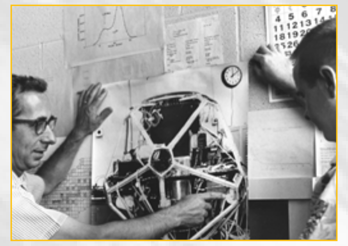
March 2007
Cibola Flight Experiment launches, demonstrating Reconfigurable Computing technology managed and operated in a space environment. CFE also explored the use of standard, commercial electronics, rather than specialized radiation-hardened electronics, for space applications.

November 2007
Launch of the last Defense Support Program satellite.

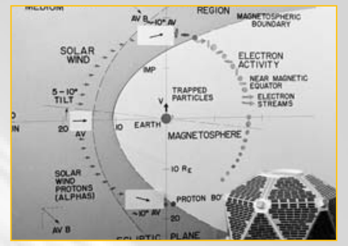
March 2008
Launch of the 50th GPS satellite to host a Global Burst Detector nuclear detonation detection payload.

May 2010
Modernized nuclear detonation detection payload launched aboard the GPS’s Block IIF series of satellites.

Scientists examine instrumentation for VELA Satellite. (1963)



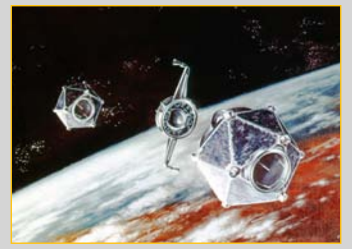
Studying photo of VELA satellite under construction. (1963)



Space Plasma Environment at the VELA satellite orbit (18 earth radii).

VELA satellite in Environmental Test Chamber. (1970)

Back-to-Back VELA Satellites prepared for launch. (1970)



Pair of VELA satellites separate in space. (Artists drawing)